

A comparison of spreader penetration depth and load required in curved canal using two types of spreaders

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Abstract:

The aim of the present study was to compare nickel titanium and stainless steel spreaders penetration depth and load in lateral compaction. Thirty curved mesial canals of extracted mandibular molars were used in the study. The canals were prepared using step-back technique with Gates-Glidden. Afterward the teeth were divided randomly into 2 groups. In part 1 of the study, the force required to insert each spreader to within 1 mm of the working length in an empty canal was measured. In part 2, the force required to insert each spreader to within 2 mm of the working length was measured in canal containing a master cone. In part 3, the depth of penetration of each spreader with a master cone in place using a 1.5 kg force was measured. Using a t-test for paired samples, the results from part 1 showed that nickel titanium spreader required high significantly less force than stainless steel spreader ($P < 0.01$). In part 2, a nickel titanium spreader required high significantly less force than a stainless steel spreader. As expected in part 3, a nickel titanium spreader penetrated to a significantly high depth than stainless steel spreader ($P < 0.01$).

Keywords:

Obturation, lateral condensation and spreaders.

Introduction:

Conventional lateral condensation of gutta-percha has been the standard against which other methods of canal obturation have been judged^(1, 2). This traditionally taught obturation techniques, require the use of force to compact gutta-percha and force scaler into the canals anatomical variations. It would seem that the greater the amount of force during condensation, the better the seal that would result. This has never been proven⁽³⁾. There has to be an upper force limit because excessive condensation force can lead to vertical fractures⁽³⁾.

In 1979, Allison et al.⁽⁴⁾ showed that a serial preparation technique, allowed a spreader to penetrate an empty canal to within 1

mm of its working length provided a better apical seal. An effort to achieve deep spreader penetration during lateral condensation; dentists have sometimes used heavy condensation force during spreader insertion. This excessive force can result in vertical root fracture during obturation. Meister⁽⁵⁾ found that 85% of root fracture caused by excessive force during lateral condensation.

There are two major sources of root distortion during obturation; the force used during lateral condensation and the flexibility of the condensing instrument⁽¹⁾. Holcomb et al.⁽⁶⁾ showed that 13% of his samples fractured with 3.5 kg of force in curved canal using D11T spreaders. Spreader design, including shape, physical properties, also seems to affect the root as to deform or fracture⁽⁷⁾. An inflexible stainless steel spreader may

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cause increased stress in the prepared root. This increased stress creates root distortion^(7,8).

Walia et al.⁽⁹⁾ has been shown that nickel titanium has greater flexibility than the stainless steel. Many authors indicate that nickel titanium files have out performed stainless steel files in curved canals^(1,2). Manufacturers have recently begun making spreaders from nickel titanium as well. Berry et al.⁽¹⁰⁾ found that nickel titanium spreader penetrated significantly closer to the working length than did stainless steel spreader when the same force was used. The newly marketed nickel titanium spreaders may offer an advantage in this regard due to more flexibility of these instruments.

Aim of the Study:

The purpose of this study was to compare nickel titanium and stainless steel finger spreaders by determining:

(1) the force required to place each spreader to within 1 mm of working length of an empty canal; (2) the force required to place each spreader to a uniform depth with a master cone in place; (3) the depth of penetration of each spreader using a standardized force with a master cone in place.

Materials and methods:

1-Sample preparation:

Thirty extracted mandibular molars with curved mesial roots were selected. The teeth were cleaned from soft tissue, and then radiographically evaluated for the degree of curvature according to Schneider technique⁽¹¹⁾. Root selected had to curve between 20° and 30°, placing them in severe category. Using a diamond disc bur with straight hand piece and water coolant, the coronal portion of the teeth were removed to eliminate the variables in the access preparation, as

well as to standardize the length of root (which should be 14 mm from the apex to the coronal end).

The canal were instrumented by step-back technique^(1,12) with K-flexofile (Dentsply, Maillefer) to ISO size 35 at the apex (working length 13 mm). After completion of apical preparation flaring was begun with 1 mm shorter stepping back to size 50. The remaining of the canal was prepared with No. #2 and #3 Gates-Glidden. Recapitulation to full working length with master apical file after each flaring file was done. Throughout procedure, 1 ml of 2.5% NaOCl irrigation solution was used between each file size.

2-Preparation of test assembly:

After root canal preparation was completed, the roots were wrapped with a single layer of aluminum foil. The roots were embedded in acrylic then removed after set; the foil was removed and replaced by silicon impression materials. This created a space of approximately 0.15 mm thicknesses which consider an artificial socket which simulated as nearly as possible the physical condition found in the socket⁽¹³⁾.

3-Test procedure:

This study has done in three parts. In part (1) spreader was inserted to within 1 mm of working length of an empty canal and the required force was recorded. In part (2) the spreader was inserted within 2mm of working length with a master cone in place, the required force was recorded. In part (3) the depth of penetration of spreader using a standardized force with a master cone in place was recorded. To measure the force for insertion the instron testing machine was used (Zwick 1454, Germany).

The teeth were randomly divided into 2 groups of 15 teeth. In each group the three parts of the study have done.

Part (1)

Group (I): nickel titanium finger spreader size B(Dentsply-Maillefer) was marked at length of 12 mm. the spreader was mounted in instron machine and inserted inside the canal, until the marking on the spreader was level with flat surface of the root. The maximum force required during the penetration was recorded.

Group (II): the same procedure for group (I) was repeated with stainless steel finger spreader size B (Dentsply-Maillefer).

Part (2)

Group (I): size 35 master gutta-percha cone was marked 13 mm from the tip. ZOE sealer (Dorifill-Doridant) was used and mixed according to the manufacturers instructions. The apical 3mm of gutta-percha was coated with sealer and placed into the canal. Complete seating was verified when rubber stopper positioned at flat surface of the root. Nickel titanium spreader marked 11mm and inserted into the canal until the mark on the spreader aligned with the flat surface of the root. The force required to insert the spreader was recorded.

Group (II): the same procedure for group (I) was repeated with stainless steel spreader.

Part (3)

Group (I): size 35 gutta-percha was placed into the canal as described in part (2) of the study. Nickel titanium spreader penetration was limited by the application of standardized 1.5 Kg force. Then spreader penetration was recorded according to position of the rubber stopper.

Group (II): the same procedure for group (I) was repeated with stainless steel spreader.

Statistical Analysis:

Independent (t) tests were used to compare group (I) to group (II) in each of the three parts of the study.

Results:

The mean force value in Kg in part (1& 2), and the mean penetration depth value in mm in part (3), with standard deviation (S.D) for each experimental group are shown in (table1).

Table (1): Descriptive statistics for experimental groups

Groups	No. of canals	Mean	S.D
Part (1)	I	15	0.38
	II	15	0.62
Part (2)	I	15	1.45
	II	15	2.32
Part (3)	I	15	11.5
	II	15	10

Figure (1) shows the bar chart graph to compare mean spreader load in Kg. while figure (2) shows the bar chart depending on the mean spreader penetration depth in mm for the two experimental groups. For part (1) the force required to insert a nickel

titanium spreader to within 1mm of the working length in an empty canal was highly significantly less (0.38 Kg vs. 0.62 Kg) than that required for stainless steel spreader ($P < 0.01$) (table2).

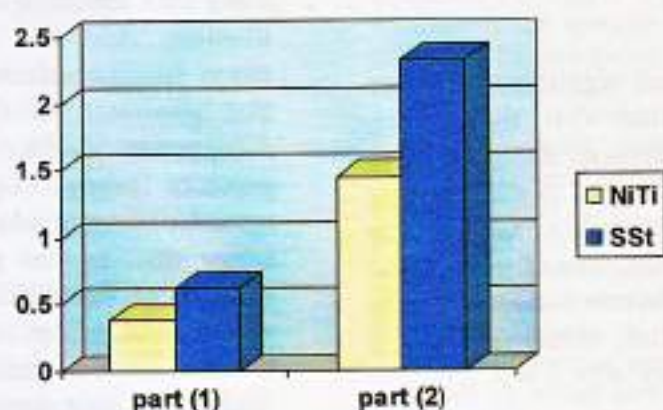


Fig. (1): Bar chart graph to compare Mean spreader load in Kg.

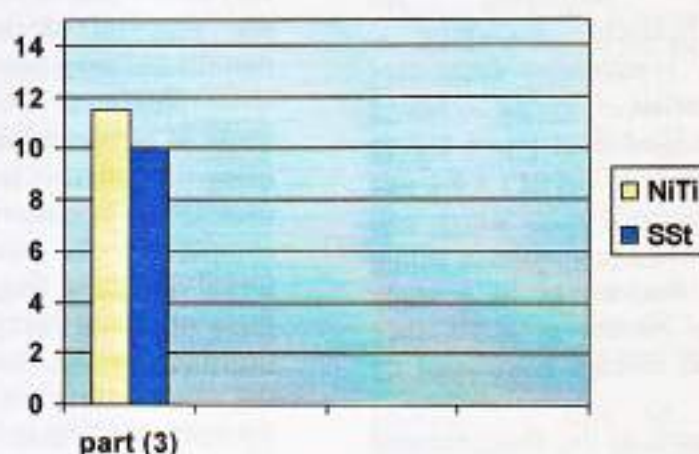


Fig. (2): Bar chart graph to compare Mean spreader penetration depth in mm

Table (2): Students t- test results comparing pairs of groups for each part of the study

Comparison groups	Df.	T	P-values	C.S.
Part(1) I vs. II	28	3.156	P<0.01	**
Part(2) I vs. II	28	4.650	P<0.01	**
Part(3) I vs. II	28	11.393	P<0.01	**

** Highly significant

For part (2) with the master cone in place the average force required to insert a nickel titanium spreader highly significantly less (1.45 Kg vs. 2.32 Kg) than that the force required for stainless steel (P<0.01).(table 2).

For part(3) the average depth of penetration of a nickel titanium with a master cone in place using a standardized 1.5 Kg force was significantly greater (11.5mm vs. 10 mm) than that for stainless steel spreader (P<0.01).(table2).

Discussion:

Rapid and significant changes for improvisation in the goals, techniques, instrument design and in the type of metal used to manufacture endodontic instruments have been developed recently. One of them is the ability to manufacture endodontic files and spreaders from nickel titanium, a super elastic alloy with a low modulus of elasticity⁽¹⁾.

Using a test assembly in this study was done to hold the tooth firmly while giving some resiliency during condensation, simulating the periodontal ligament. According to Harvey et al.⁽¹⁴⁾ maximum force used by endodontists during lateral compaction ranged from 1 to 3 Kg. in part 3 of the study a load of 1.5 Kg was used as standardized force which was found to produce a homogenous filling without root fracture as in a study conducted by Jerome et al.⁽¹⁵⁾, they consider as an average force used by endodontists.

The result of the study showed that the load required to insert nickel titanium spreaders to within 1 mm of the working length in an empty canal was highly significantly less than the force required to insert stainless steel spreader to the same depth ($P < 0.01$). Less load was also required to insert a nickel titanium spreaders to within 2 mm of the working length in canals containing a master cone ($P < 0.01$). These finding agree with the result of Schmidt et al.⁽¹⁶⁾. This attributed to the fact that nickel titanium instrument have 2-3 times more elastic flexibility when compared with the same size of stainless steel instrument. The metal has a low bending moment, high spring back, and low stiffness contributing to its unique flexibility.

The force required to insert stainless steel spreaders to within 2 mm of working length was more about

1 Kg than the force required for nickel titanium. And this may cause more stress because of the wedging effect that generated in the canal by the compaction strain. In addition the pressure exerted by stainless steel spreader transmitted to the dentin walls rather than to the gutta-percha cone because of the stiffness of the metal which tend to follow a straight line within curved canal⁽⁸⁾. Dang and Walton⁽¹⁷⁾ have been speculated that actual fracture may not occur at the time the force is applied, rather, the distortions created during the procedures may accumulate in dentin and manifest as an actual fracture months and even years later.

Joyce et al.⁽¹⁸⁾ conducted a study to compare the stress induce by using stainless steel and nickel titanium spreaders in lateral compaction. He concluded that with nickel titanium finger spreaders the force of lateral compaction is equally distributed along the entire length of the canal with more concentration at the apex resulting in better compaction of the gutta-percha. With stainless steel spreaders, the forces of lateral compaction are actually concentrated at three locations, one near the canal orifice on the convex side, second in the middle of the canal on the concave side and third near the apex on the convex side. These spots considered the main cause of vertical root fracture.

In part three of the study, when a standardized force was used, nickel titanium spreaders penetrated 1.5mm further in the canals with a master cone in the place than stainless steel. This finding coincide with the findings of Sobhi et al.⁽¹⁹⁾, Shull et al.⁽²⁰⁾. In an vivo study Sobhi et al.⁽¹⁹⁾ found that nickel titanium penetrated significantly closed to the working length than did stainless steel spreader, and the penetration of stain less steel spreader

decreases with increases of root curvature.

The condensation force is not the most important factor in establishing a suitable apical seal⁽³⁾. Spreader penetration within 1 to 2 mm of the apex has been shown to have a significance effect on the quality of the apical seal^(3,4). Stainless steel spreader failed to reach the apical 2mm due to their inflexibility and this can result in an improper compaction of gutta-percha cone to the walls of the apical area. Excessive compaction pressure in order to place the spreader to the proper working length may cause root distortion. Two sample from group (2) and one sample from group (1) in part 2 were eliminated from the study because the spreader could not be inserted to 11mm. This may have been due to a ledged canal or inadequate root canal preparation.

The results of this study show that nickel titanium spreaders penetrated deeper with standardized force and require less force to penetrate to a standardized distance than do stainless steel spreaders. Therefore, the potential for root distortion in curved canals during lateral condensation may be minimized by using nickel titanium spreaders.

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